# Boulder Project

# Air Quality Specialist Report

Giant Sequoia National Monument
Hume Lake Ranger District

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## Introduction

Projects that involve the use of fire have the potential to affect air quality. Smoke from fires can affect human health, impair scenic vistas, create safety hazards, and/or cause a general nuisance. The purpose of this report is to evaluate air quality consequences and propose mitigations that can minimize effects. Wildfire suppression techniques in this area have historically produced limited opportunities to mitigate emissions, primarily due to timing. Wildfire events have typically occurred during summer high background air pollution days. The proposed action offers an opportunity to control seasonal timing, ignitions, and other variables that can reduce emissions and/or public exposure.

## Relevant Laws, Regulations, and Policy

The air quality regulatory structure and agencies responsible for compliance are as follows:

- Federal – Environmental Protection Agency (EPA).
- State – California Air Resources Board (CARB).
- Local – San Joaquin Valley Air Pollution Control District (District).

***Environmental Protection Agency (EPA)***. The federal government sets air quality standards, oversees state and local actions, and implements programs for toxic air pollutants, heavy duty trucks, locomotives, ships, aircraft, off-road diesel equipment, and some types of industrial equipment. The role of federal, state, and local governments is defined in the Clean Air Act and its amendments of 1977 and 1990.

Some of the principal components, regulations, and policies related to the Clean Air Act that may directly or indirectly affect planning in the project area are discussed below.

- *National Ambient Air Quality Standards (NAAQS)* – These are standards for pollutants considered harmful to public health and the environment. The EPA has set NAAQS for six principal pollutants, which are called “criteria pollutants” (see Table 1: National Ambient Air Quality Standards). Smoke contributes to PM10, PM2.5, and to a lesser degree NO2, CO, and O3.
- *Class I Areas* – These include National Parks, Wilderness Areas, and some U.S. Fish and Wildlife Refugees that were in existence at the passage of the 1977 Clean Air Act amendments. These areas are provided special protection from new and modified major stationary sources. Federal land managers are mandated an affirmative responsibility to protect values that might be impacted by air pollution, including visibility.

- *Regional Haze Rule* – These regulations require states to review how pollution emissions within the state affect visibility at "Class I" areas across the region. These rules also require states to make "reasonable progress" in reducing effects from this pollution on visibility conditions in Class I Areas and to prevent the future impairment of visibility. The states are required by the rule to analyze a pathway that takes the Class I Areas from current conditions to "natural conditions" in 60 years. "Natural conditions" is a term used in the Clean Air Act that means that no human-caused pollution can impair visibility. This program, while aimed at Class I Areas, will improve regional visibility and air quality throughout the country.

- *Conformity Rule* – This rule implements the Clean Air Act conformity provision, which mandates that the federal government not engage, support, or provide financial assistance for licensing or permitting, or approve, any activity not conforming to an approved State Implementation Plan in federal non-attainment areas. Federal actions will not:

  - Cause or contribute to new violations,
  - Increase the frequency or severity of existing violations, or
  - Delay timely attainment or interim emission reductions.

  Projects that are planned in compliance of a state smoke management program satisfy conformity requirements. The Boulder Project will meet Title 17 and subsequent SJVAPCD rules which constitute California's approved Smoke Management Program.

- *EPA Interim Policy on Wildland and Prescribed Fire* – This EPA interim policy integrates two public policy goals: (1) to allow fire to function, as nearly as possible, in its natural role in maintaining healthy wildland ecosystems, and (2) to protect public health and welfare by mitigating the impacts of air pollutants on air quality and visibility.

### Table 1: National Ambient Air Quality Standards

| Pollutant | Averaging Time | Federal Standard |
|---|---|---|
| Ozone | 8 hour | 0.075 parts per million (ppm) |
| Respirable Particulate Matter ($PM_{10}$) | 24 hour | 150 $\mu g/m^3$ |
| Nitrogen Dioxide ($NO_3$) | Annual Arithmetic Mean | 0.053 ppm |
| Fine Particulate Matter ($PM_{2.5}$) | 24 hour | 35 $\mu g/m^3$ |
| | Annual Arithmetic Mean | 15 $\mu g/m^3$ |
| Carbon Monoxide (CO) | 8 hour | 9 ppm |
| | 1 hour | 35 ppm |
| Sulfur Dioxide ($SO_2$) | Annual Arithmetic Mean | 0.030 ppm |
| | 24 hour | 0.14 ppm |
| Lead | Rolling Three Month average | 0.15 $\mu g/m^3$ |
| Lead | Quarterly Average | 1.5 $\mu g/m^3$ |

Source: EPA. Accessed online 9/28/2012 at http://www.epa.gov/air/criteria.html.

***California Air Resources Board (CARB).*** State governments are responsible for developing State Implementation Plans (SIP). These describe how each state will achieve the requirements of the Clean Air Act. In California, the SIP is a collection of regulations used to clean up polluted areas. EPA maintains oversight authority, must approve each SIP, and can take over enforcement action if reasonable progress is not made. CARB has set more stringent standards(see Table 2), oversees state and local actions, and implements programs for toxic air pollutants, heavy-duty trucks, locomotives, ships, aircraft, off-road diesel equipment, and some types of industrial equipment. In 2006, the California Legislature passed and Governor Schwarzenegger signed AB 32, the Global Warming Solutions Act of 2006, which set the 2020 greenhouse gas emissions reduction goal into law. It directed the California Air Resources Board to begin developing discrete early actions to reduce greenhouse gases while also preparing a scoping plan to identify how best to reach the 2020 limit.

### Table 2: California Air Quality Standards

| Pollutant | Averaging Time | Federal Standard |
|---|---|---|
| Ozone | 1 hour | 0.09 parts per million (ppm) |
| | 8 hour | 0.07 ppm |
| Respirable Particulate Matter ($PM_{10}$) | 24 hour | 50 µg/$m^3$ |
| | Annual Arithmetic Mean | 20 µg/$m^3$ |
| Nitrogen Dioxide ($NO_3$) | Annual Arithmetic Mean | 0.030 ppm |
| | 1 hour | 0.18 ppm |
| Fine Particulate Matter ($PM_{2.5}$) | Annual Arithmetic Mean | 12 µg/$m^3$ |
| Carbon Monoxide (CO) | 8 hour | 9 ppm |
| | 1 hour | 20 ppm |
| Sulfur Dioxide ($SO_2$) | 24 hour | 0.04 ppm |
| | 1 hour | 0.25 ppm |
| Lead | 30 Day Average | 1.5 µg/$m^3$ |

The Smoke Management Guidelines for Agricultural and Prescribed Burning (Title 17) are the regulatory basis for California's Smoke Management Program. Amendments to California's Title 17 may directly or indirectly affect planning in the Giant Sequoia National Monument. The smoke management guidelines became effective on March 14, 2001. Local air pollution control districts use these guidelines in local rule development.

***San Joaquin Valley Air Pollution Control District (District).*** Local air pollution control districts in California develop plans and implement control measures in their areas of jurisdiction. These collectively make up California's SIP. These controls primarily affect stationary sources but also include non-stationary sources of dust and smoke. The District also conducts public education and outreach. The District is comprised of eight counties that share a common air district: Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare Counties. The following District regulations may directly or indirectly affect the Boulder Creek Fuels Restoration Project::

- Public Nuisance (Rule 4102) – Prohibits air discharge of material that causes nuisance or annoyance to any considerable number of people.

- Prescribed Burning and Hazard Reduction (Rule 4106) – This rule was adopted June 21, 2001, in response to California's Title 17, and is designed to permit, regulate, and coordinate the use of prescribed burning and hazard reduction burning while minimizing smoke impacts on the public.

The Giant Sequoia National Monument Management Plan (USDA 2012) also contains several standards and guidelines to maintain or improve air quality. The following list are those that are applicable to the Boulder Creek Fuels Restoration Project (Monument Plan pp. 86-87):

1. Continue the visibility monitoring program and determine sensitive indicators for each air quality-related value in national forest class I areas. Protect air quality-related values by reviewing all projects and management activities that may affect those values. Review external prevention of significant deterioration (PSD) source applications and make recommendations to permitting authorities.

2. Minimize resource and air quality effects from air pollutants generated by management activities through use of the following control measures:

    a. Follow dust abatement procedures.
    b. Conduct an air quality analysis for all projects that may impair air quality to determine effects, mitigations, and/or controls.
    c. Respond to local planning and regulatory authorities when development outside forest jurisdiction may affect forest resources.

    d. Conduct prescribed burning activities in accordance with air pollution control district regulations and with proper prescriptions to assure good smoke management.

    e. Notify the public before burning.

3. Minimize smoke emissions by following best available control measures (BACMs). Avoid burning on high visitor days. Notify the public before burning.

4. Coordinate and cooperate with other agencies and the public to manage air quality. Conduct prescribed burns when conditions for smoke dispersal are favorable, especially away from sensitive or class I areas. Use smoke modeling tools to predict smoke dispersion.

## Analysis Questions

Although no questions related to air quality were raised during scoping, air quality and smoke management continue to be a critical issue in the San Joaquin Valley and Great Basin air basins that lie adjacent to each side of the southern Sierra Nevada range. Project design and timing is being developed to minimize smoke effects. Prescribed fire would be ignited in the fall, with some limited ignitions in the spring. Fall ignitions are planned to follow late summer high ozone events and prior to significant $PM_{2.5}$ events associated with community residential wood burning. Ignitions would be targeted to occur just before significant season ending weather events.

A Smoke Management Plan (contained in all prescribed fire plans) must be submitted and approved by the APCD prior to using prescribed fire. As part of the Smoke Management Plan the Forest Service must provide a detailed meteorological prescription that must be met prior to igniting a prescribed burn. At a minimum, the prescription must include acceptable wind direction. Other considerations include wind speed, temperature profile, winds aloft, humidity, temperature, actual and predicted inversions, burn day status and forecast, precipitation forecast, and any other meteorological conditions, which may affect smoke dispersion and/or the fire behavior. The Smoke Management Plan has elements that assist in mitigating smoke.
Fine particulate matter less than 2.5 microns in diameter (PM2.5) is the emission metric that will be used to compare alternatives and to assess public exposure issues.

Particulate matter in ambient air is composed of complex mixtures of inorganic and organic species. The mixture is made up of liquid or solid particles suspended in the air. These particles vary in origin, size, and composition. Major components of $PM_{2.5}$ include nitrate, sulfate, ammonium, organic carbon, and elemental carbon (Chow et al. 1994).
$PM_{2.5}$ is made up of combustion particles and re-condensed organic and metal vapors, and contains secondarily formed aerosols from gas to particle conversion (WHO 2003, Liu et al. 2003, Harrison et al. 2001). $PM_{2.5}$ particles form mainly from high temperature sources or gas to particle conversion processes within the atmosphere (Harrison et al. 2001).
Particles formed from gases through nucleation originate mainly from anthropogenic sources such as combustion from motor vehicles, power generation, industry, and from residential fireplace and wood stoves (Liu, et al. 2003). Vehicular traffic has been shown to be an important source of fine particles, especially near busy roads (WHO, 2003, Gertler et al. 2000). Photochemical production of fine aerosols such as sulfate, nitrate, and organic aerosols increases in the summer months in the presence of higher concentrations of ozone (Parkhurst, et al. 1999).

In the regulatory framework, PM is divided into fine and coarse particles. Fine particles are defined as particles with an aerodynamic diameter of less than 2.5 µm. Fine particles are made up of combustion particles, organic and metal vapors, and contain secondarily formed aerosols from gas to particle conversion (Liu et al. 2003, Harrison et al. 2001, WHO 2003). Coarse particles are defined as particles with an aerodynamic diameter between 2.5-10 µm. The coarse particles are mostly composed of crust materials and dust from roads and industries (Liu et al. 2003, WHO 2003). $PM_{2.5}$ is defined as particles with an aerodynamic diameter less than 2.5 µm. $PM_{10}$ is defined as particles with an aerodynamic diameter of less than 10 µm.

Short term exposure to Particulate Matter has been associated with negative effects to human health. Long term exposure to Particulate Matter is believed to have a much greater impact on human health, but is less certain because less is known about it (Koelemeijer et al. 2006). It has been suggested that life expectancy is lower for people living in areas with high Particulate Matter levels (Houthuijs et al. 2001). Fine particle concentration ($PM_{2.5}$) are associated with adverse health effects on the general population; including increased mortality and morbidity, reduced lung function, increased respiratory symptoms (such as chronic cough or bronchitis), aggravated respiratory and cardiovascular disease, eye and throat irritation, coughing, breathlessness, blocked and runny noses, and skin rashes (Radojevic 1998, Houthuijs et al. 2001). Short exposure to $PM_{10}$ increases mortality, hospital admissions, respiratory symptoms, and reduces pulmonary function (Houthuijs et al. 2001). Long term exposure to $PM_{10}$ has adverse effects on respiratory health as well.

There is strong evidence to suggest that $PM_{2.5}$ is more hazardous to human health than $PM_{10}$ in terms of cardio pulmonary disease, and mortality (WHO 2003). Thus epidemiological studies in the last decade have emphasized the negative health effects are mainly related to the increase in levels of fine particulate matter in the atmosphere of sizes of less than 2.5 mm (Querol et al. 2007). Fine particles measured as $PM_{2.5}$ are strongly associated with mortality and hospitalization for cardio pulmonary diseases (WHO 2003). Smaller particles induce more inflammation than larger particles on a mass basis. The reduction in life expectancy is primarily due to increased cardio pulmonary disease and lung cancer mortality. The increases in cardio pulmonary disease are likely in lower respiratory symptoms and reduced function in children, and chronic obstructive pulmonary disease and reduced lung functions in adults (WHO 2003).
In addition to primary pollutants that impact human health, the forest fires also generate, Black carbon (BC) and Greenhouse Gases (GHGs) like Carbon dioxide ($CO_2$), Methane ($CH_4$), Nitrous oxide ($N_2O$) that impact climate.

## **Existing Conditions**

### GENERAL METEOROLOGY, CLIMATE, AND TRANSPORT

The Boulder project area lies in the jurisdiction of the eastern portion of the San Joaquin Valley Air Pollution Control District (SJVAPCD) and adjacent to the Great Basin Air Pollution Control District (GBAPCD) to the east (figure 1). The San Joaquin Valley has a northwest to southeast orientation, approximately 100 miles wide by 300 miles long. Major urban centers including Bakersfield, Fresno, Modesto, and Stockton and large agricultural areas are adjacent to the project area.

Air pollution is typically generated in urban and agricultural areas west of the Monument and moved toward the Monument by prevailing west-to-east winds. Air circulation and the movement of smoke and other pollutants in the San Joaquin Valley are restricted in both vertical and horizontal directions. Vertical air movement is restricted by radiation and subsidence inversions. A nocturnal inversion forms in the San Joaquin Valley nearly every day of the year. During all seasons in the valley, the inversion base is 500 feet or less from the ground surface. In the winter, due to lower sun angle, heating is reduced and the inversion base is 1,000 to 1,500 feet above the ground surface. During the rest of the year, the inversion base often lifts to1,500 to 3,000 feet above the ground surface by mid-day. In the summer, the inversion layer can break down. Air quality in the project area is typically better when the inversion is lower. Localized night-time radiation inversions in mountain valleys are also common and are normally the main drivers of smoke impacts on public health.

The meteorology of the San Joaquin Valley has a significant influence on pollutant transport, including ozone and secondary particle formation in the region. Weather patterns moving from the California Central Valley carry pollutants generated in the Valley and deposit them in the central and southern Sierra Nevada foothills and mountains (Zabic and Seiber 1993).

Summer wind patterns in the Sierra Nevada Mountains are complex due to rugged terrain and intense daytime solar radiation. During summer months, the predominant surface wind direction in the San Joaquin Valley is from the northwest to southeast, down valley from Stockton towards Bakersfield. In Fresno, the morning surface flow is frequently from the south or west and is characterized by light wind speeds. Wind speed increases during the day, shifting towards a northwest to southeast direction, and peaking around 5:00 p.m. Pacific Daylight Time (Ewell, et al. 1989.).

The general summer daytime flow can be slightly, but significantly, modified in the late evening and early morning hours. The modified pattern occurs when ozone concentrations in the valley are high. The influence of two major phenomena, the nocturnal jet and the Fresno eddy, which regularly occur during the ozone season, have significant influence on ozone concentrations in the valley (Roberts et al. 1990). The jet stream provides a mechanism for rapid transport of pollutants from north to south, while the eddy cycles pollutants in the southern part of the valley, possibly leading to increased concentrations.

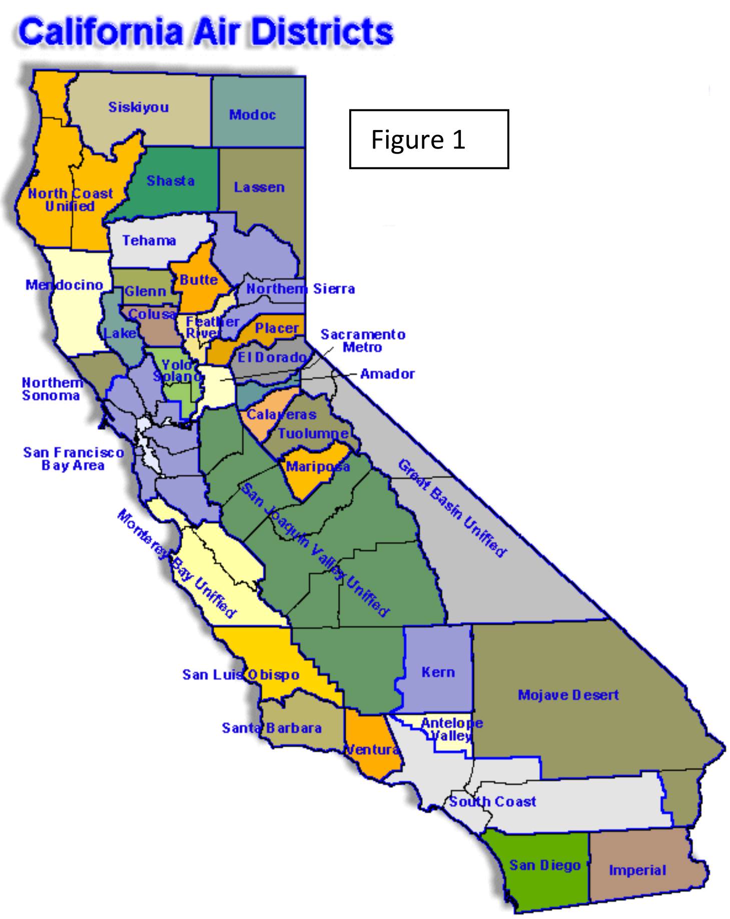

Figure 1

Horizontal air movement is restricted on three sides by mountains that surround the San Joaquin Valley. These include the Coastal Mountains to the west, the Tehachapi Mountains to the south, and the Sierra Nevada to the east. Exceptions can occur when smoke at higher elevations is transported over these mountain ranges. This has been a fairly common occurrence from higher elevations in the Sierra Nevada to the Great Basin in the east. In the spring and summer, when the marine layer is shallow, westerly winds enter through low coastal gaps, primarily the Carquinez Straits, and flow toward the southeast of the San Joaquin Valley. During winter months, wind flows in the valley are from the south, with stagnant conditions prevailing except during passage of winter storm systems. Daytime wind speed increases as the valley heats up and is strongest in the afternoon. During storm-free periods in the fall and winter, the airflow is more variable, with light wind speed resulting in less air movement from the valley. At these times, the project area will typically experience the best air quality. Daily and seasonal variation in air pollution and smoke movement are dependent upon these air transport mechanisms. The Boulder Project is located in the east-west oriented canyon formed by the South Fork of the Kings River. It is generally above the inversion layer is fall, winter, and spring months while summer months provide enough heating of the airshed to transport pollutants into higher elevations.

During the day, air near the mountain slopes is heated, resulting in upslope and up-valley winds. With the loss of solar heating in the evening as the sun sets, the process is reversed. Terrain-driven winds provide a means to diurnally transport of pollution out of, and back into, the valley (Blumental, et al. 1985). Several studies have demonstrated pollutant transport into the mountains (Lehrman, et al. 1994, Shair 1987, Tracer Technologies 1992).

## REGULATORY AIR QUALITY CONDITION

Regulatory status and trends of air pollutants are generally measured against the National and California Ambient Air Quality Standards. Those standards are developed to protect public health. A Federal non-attainment status for a specific pollutant indicates that the air regulatory jurisdiction is NOT meeting the standard. That status results in required submittals of plans with proposed control strategies that are modeled to bring an area into compliance/attainment by specific time frames. The San Joaquin Valley APCD and Great Basin APCD regulatory status follows:

| **Pollutant** | **Designation/Classification by Air Pollution Control District** | | | |
|---|---|---|---|---|
| | **Federal Standards** | | **State Standards** | |
| | San Joaquin APCD | Great Basin APCD | San Joaquin APCD | Great Basin APCD |
| Ozone - One hour | No Federal Standard | | Non-attainment/ Severe | Non-attainment (Inyo and Mono Counties)<br><br>Unclassified (Alpine County) |
| Ozone - Eight hour | Non-attainment/ Extreme | Attainment/ Unclassified | Non-attainment | |
| PM 10 | Attainment | Non-attainment (Owens Lake and Mono Basin) | Non-attainment | Non-attainment |
| PM 2.5 | Non-attainment | Attainment/ Unclassified | Non-attainment | |

| | | | | |
|---|---|---|---|---|
| Carbon Monoxide | Attainment/ Unclassified | Attainment/ Unclassified | Attainment/Unclassified | |
| Nitrogen Dioxide | Attainment/ Unclassified | Attainment/ Unclassified | Attainment | |
| Sulfur Dioxide | Attainment/ Unclassified | Attainment/ Unclassified | Attainment | |
| Lead (Particulate) | No Designation/ Classification | Attainment/ Unclassified | Attainment | |
| Hydrogen Sulfide | No Federal Standard | | Unclassified | |
| Sulfates | No Federal Standard | | Attainment | |
| Visibility Reducing Particles | No Federal Standard | | Unclassified | |
| Vinyl Chloride | No Federal Standard | | Attainment | |

## SMOKE SENSITIVE AREAS

Smoke sensitive areas include campgrounds, residences, camps, and visitor centers in the areas of Hwy 180, Cedar Grove, Hume Lake, Big Meadows, and Grant Grove. Further from the project, other potential areas of concern might include lower elevations within the Kings River drainage and northeast to east in the Great Basin from around Mammoth to Bishop and Lone Pine.

Federal Land Managers have a responsibility to protect visibility in Class I areas. Class I areas in the vicinity of the project include Kings Canyon National Park, Sequoia National Park, John Muir Wilderness, Dinky Lakes Wilderness, and Kaiser Wilderness. Although smoke management objectives are intended to minimize smoke intensity and duration in Class I areas, smoke is recognized by federal land managers and EPA policy to have a role in natural systems. California's Regional Haze State Implementation Plan was developed to identify causes of visibility impairment in Class I areas and propose actions that will remedy visibility impairment by 2060. California's plan acknowledges that the primary contribution to poor visibility in Sierra Nevada Class I areas is organics from wildfire smoke events.

## DEPOSITION

Atmospheric deposition includes nutrients in several forms, with two of the most important being sulfur and nitrogen. Both nitrogen (N) and sulfur (S) are transferred into ecosystems through wet and dry deposition processes. The primary gases involved with N deposition include ammonia ($NH_3$), nitrogen oxides ($NO_x$), and nitric acid ($HNO_3$), while the primary particles are nitrate ($NO_3^-$), and ammonium ($NH_4^+$). $NO_x$ and $HNO_3$ are emitted as a result of high temperature combustion (e.g. power plants, cars, industrial facilities), while ammonia ($NH_3$), nitrate ($NO_3^-$), and ammonium ($NH_4^+$) are most often from agricultural sources. Sulfur dioxide ($SO_2$) is the dominant sulfurous pollutant emitted by anthropogenic sources, including fossil fuel combustion and industrial processes. Sulfur is transferred to ecosystems through wet deposition of sulfate ($S0_4$), as well as dry deposition of sulfate particles and gaseous $SO_2$.

Nutrients, including N and S, are essential to the health of wildland ecosystems. Excess inputs from anthropogenic sources, however, can alter natural processes through enrichment and acidification effects. Deposition to terrestrial systems can cause chemical alterations to soil, affecting soil microorganisms and native vegetation. Ecosystem species composition and abundance may change as plants adapt to their new environment. Aquatic plants, invertebrates, amphibians, and fish are affected through water body acidification and eutrophication.

Urbanization, rapid population growth, and widespread agricultural practices have established nitrogen deposition as a significant issue for California. Sulfur deposition is generally low within the state, although local and sub-regional impacts to individual wilderness areas may occur.

$NO_x$ emissions in California are produced by mobile sources (85%), stationary sources (12%), and area-wide sources (3%). $NH_3$ emissions are from biogenic sources (41%), cattle and other livestock (38%), fertilizer (7%), on-road mobile (4%), and other sources (10%) (CARB, 2000). The counties with the highest $NO_x$ and $NH_3$ emissions are either heavily populated and/or agricultural. Sulfur emissions are produced by mobile sources (59%), stationary sources (39%) and some minor area sources (2%).

Forests with the highest N loading are those downwind of the major urban centers in Southern California and the urban and agricultural centers of the San Joaquin-Sacramento Valley. Nitrogen loading remains low in the northern part of the state, along the eastern Sierra and Mojave Desert, and low-moderate along the central and northern California coast.

## OZONE

Ozone occurs in the troposphere as the result of chemical reactions involving the photochemical precursors volatile organic compounds (VOCs), nitrogen oxides ($NO_x$), and solar radiation. Conditions favoring high ozone concentrations include inversion layers and low wind speeds, which limit pollutant dispersion and hot, sunny weather which provides energy for the chemical reactions to occur. These conditions occur in California predominantly during the summer

months, resulting in peak ozone concentrations from May through September. Diurnal patterns of O3 generally include a rise from minimum concentrations to an early afternoon peak.
O3 and ozone precursors from urban areas are transported to rural downwind locations, resulting in elevated ozone concentrations at considerable distances from urban sources (EPA, 1996). O3 tends to persist longer in rural locations due to the absence of chemical scavenging, resulting in concentrations that may actually be higher than those in developed areas (EPA, 1996).
Ozone is the gaseous pollutant most harmful to crops, trees, and native vegetation (EPA, 1996), and the only large-scale gaseous air pollutant that has been measured at phytotoxic levels in remote locations (EPA, 1996). Ozone is a strong oxidizing agent that damages plant cells when taken up through stomates, requiring plants to expend energy for detoxification and repair rather than growth (FLAG, 2000). The plant injury response can be used to evaluate overall ozone stress in forests and shrub lands. Bioindicators are native, ozone-sensitive plant species, which will exhibit characteristic foliar injury symptoms when exposed to ambient ozone. In California, trees known to be ozone-sensitive include ponderosa and Jeffrey pine. Ozone can affect entire ecosystems as well as sensitive individuals, for example, species composition in ozone-impacted areas may shift in favor of individuals and plant species with greater ozone tolerance. Such a shift has been documented in the San Bernardino Mountains of southern California (EPA, 1996).

## VISIBILITY

The relative importance of regional haze constituents varies between California sub-regions. In the Sierra Nevada, organic carbon makes the greatest contribution to visibility impairment on the worst visibility days. Sulfates and nitrates are also critical components of haze in the region.

Visibility impairment is driven primarily by organic carbon from wildfire smoke, followed in importance by sulfates and nitrates (CARB)**.** Visibility is worst during the summer months, due to smoke from California wildfires and biogenic emissions. Sulfates and organic carbon make the greatest contributions to impairment on the best days, with sulfates dominating in the northern part of the range, and organic carbon dominating in the south. Organic carbon is the major haze component for the worst visibility days. The sole exception is the low elevation Sequoia National Park site, which is impacted by its' proximity to the Central Valley **(**CARB)**.** Elemental carbon and coarse mass (dust) also contribute to impairment on both best and worst days.

Source apportionment modeling was conducted at the WRAP (Western Regional Air Partnership) Regional Modeling Center at the University of California, Riverside in order to identify sources responsible for visibility impairment within the region. Natural and anthropogenic sources within California, the Pacific Ocean, sources in neighboring states, and international sources all contribute to haze in the Sierra Nevada.

The largest contributors to primary organic carbon are natural fire sources within California and Nevada, area sources, and anthropogenic fires. California fires produce the majority of organic carbon emissions for all sites, ranging from 70-99%. BLIS (The visibility monitoring station at Bliss State Park at Lake Tahoe) is also affected by wildfire smoke from Nevada. Source attribution for sulfates and nitrates indicates that most sulfates (45%) are produced outside the

WRAP modeling domain, while the majority of nitrates (76%) are emitted from sources located within California.

## Alternatives and Mitigations

Alternative 1 – No Action

Current management plans under the No Action Alternative would continue to guide management of the project area. No prescribed fire activities would be implemented to accomplish project goals. Therefore special mitigations would not be necessary under this alternative.

Alternative 2 – Proposed Action

Alternative 2 proposes to use prescribed fir to reintroduce fire into the lower portion of the Boulder Creek drainage. The project area encompasses approximately 14,385 acres of the watershed, of which 6,000 to 9,000 acres is proposed for underburning.

Smoke management is a critical issue in the San Joaquin Airshed. This project is being designed to limit the impact smoke would have on the airshed. Prescribed fires would be ignited in the fall, with some limited ignitions in the spring, prior to predicted rain/snow events. This would allow the prescribed fire to burn long enough to achieve resource goals before wetting rains or snow extinguish the active burning in the project area. The duration of active burning and smoke impacts on the airshed is expected to be two weeks.

Mitigations: California's Title 17 constitutes an EPA approved Smoke Management Program (SMP) that includes wildland prescribed burns. The California Air Resources Board and the San Joaquin Valley Air Pollution Control District (SJVAPCD) regulate prescribed burns through careful coordination and allocation of acres burned on days meteorologically capable of dispersing emissions.

***Prescribed Fires and Presumption of Conformity***…The EPA has included a presumption of conformity in the revised conformity (2010) rules for prescribed fires that are conducted in compliance with a SMP. SJVUAPCD and GBUAPCD have an established SMP in accordance with CA title 17 that has been approved as a Smoke Management Program by the EPA. The Boulder burns will be conducted under established SMPs that will meet the conformity determination requirement.

A smoke management plan must be submitted and approved by the SJVAPCD prior to the project. As part of the plan the Forest Service must provide a detailed meteorological prescription that must be met prior to igniting any of the burning operations. At a minimum the prescription must include acceptable wind direction. Other considerations include wind speed, temperature profile, winds aloft, humidity, temperature, actual and predicted inversions, burn day status and forecast, precipitation forecast, and any other meteorological conditions which may affect smoke dispersion and/or fire behavior. The plan must also contain contingency measures in the event smoke impacts smoke sensitive areas. Smoke sensitive areas must be delineated in the plan.

The Sequoia National Forest operates a comprehensive air quality and smoke monitoring program. The program emphasizes instrumentation that provides near real-time data for fine particles, ozone and meteorology. Instrumentation will be placed at smoke sensitive areas and will be used to coordinate with the SJAPCD and the Great Basin Unified Air Pollution Control District. Information will be coordinated to assist in mitigating public exposure. In addition, an Air Quality Specialist will be assigned to provide smoke forecasts utilizing the monitoring data and predictive models.

## Methodology and Analysis Process

$PM_{2.5}$ and $CO_2$ emissions were calculated using the methods outlined by the General Conformity State Implementation Plan Handbook (USDA Forest Service 1995). The emissions calculations used the total number of acres to be treated, vegetation type, estimated fuel loading, and an emissions factor. The emission calculation formula is as follows:

$$E = (A \times L \times EF \times \%C)/2000 \text{ (tons) where}$$

E=Emissions generated (tons)
A=Area being treated (acres)
L= Fuel Loading (tons/acre)
EF= Emission factor (pounds/ton) of fuel consumed
C= Percent Combustion

## Effects Analysis

### *Direct and Indirect Effects*

Current management plans under the No Action Alternative would continue to guide management of the project area. No prescribed fire activities would be implemented to accomplish project goals. Therefore special mitigations would not be necessary under this alternative. However, fire severity and intensity would continue to increase as fuel loading naturally increases. The absence of burning Alternative 1 would likely ensure low emissions in the short term but with the continued accumulation of fuels, in a wildfire scenario, would risk the production of high emissions and high risk of public exposure. Wildfires in this area tend to occur in late summer months when background fine particles and ozone are high, compounding public exposure risk.

Alternative 2 is designed to meet Title 17 and subsequent District rules which constitute California's approved Smoke Management Program. Compliance with the state Smoke Management Program also satisfies the conformity requirements under the Clean Air Act. In addition, the Giant Sequoia National

Monument Management Plan (USDA 2012) contains several standards and guidelines to maintain or improve air quality, of which the following are applicable to the Boulder Project:

- Minimize resource and air quality effects from air pollutants generated by management activities through use of the following control measures:
    - Follow dust abatement procedures.
    - Conduct an air quality analysis for all projects that may impair air quality to determine effects, mitigations, and/or controls.
    - Conduct prescribed burning activities in accordance with air pollution control district regulations and with proper prescriptions to assure good smoke management.
    - Notify the public before burning.
- Minimize smoke emissions by following best available control measures (BACMs). Avoid burning on high visitor days. Notify the public before burning.
- Coordinate and cooperate with other agencies and the public to manage air quality. Conduct prescribed burns when conditions for smoke dispersal are favorable, especially away from sensitive or class I areas. Use smoke modeling tools to predict smoke dispersion.

Since smoke management is a critical issue in the San Joaquin Airshed, Alterntive 2 is designed to limit the impact smoke would have on the airshed by proposing prescribed burns in the fall, with some limited ignitions in the spring, prior to predicted rain/snow events. This would allow the prescribed fire to burn long enough to achieve resource goals before wetting rains or snow extinguish the active burning in the project area. The duration of active burning and smoke impacts on the airshed is expected to be two weeks. The timing of the prescribed burns would also be coordinated with the California Air Resources Board and the San Joaquin Valley Air Pollution Control District in compliance with Title 17, the Smoke Management Program and the Monument Plan. These requirements and the two additional mitigation measures would reduce the potential direct and indirect impacts to air quality from smoke and particulates entering the airshed (See page 8 of this document).

Boulder Creek drainage is considered an area requiring restoration indicating the fuel loading is outside the range of natural variability and, as such, a portion of the emissions generated would also be outside the range of natural variability. Although the emissions generated (Table 5) are not indicative of public exposure or effects they do provide a relative understanding of the total release to the atmosphere.

**Table 3: Annual Emissions under Alternative 2 (tons)**

| Year | $PM_{2.5a}$ | $PM_{10b}$ | $CO_c$ | $CO_{2d}$ | $CH_{4e}$ | $NMHC_f$ | $NOX_g$ | $N_2O_h$ | $GHGs_i$ |
|---|---|---|---|---|---|---|---|---|---|
| **1** | 346 | 377 | 3699 | 58249 | 236 | 180 | 110 | 6 | 65022 |
| **2** | 869 | 947 | 9291 | 146297 | 592 | 453 | 277 | 15 | 163307 |
| **3** | 263 | 287 | 2812 | 44276 | 179 | 137 | 84 | 4 | 49424 |
| **4** | 395 | 431 | 4223 | 66499 | 269 | 206 | 126 | 7 | 74231 |
| **5** | 263 | 287 | 2812 | 44276 | 179 | 137 | 84 | 4 | 49424 |
| | | | | | | | | | |
| EF (lbs/ton) | **18.8** | **20.5** | **201** | **3165** | **12.8** | **9.8** | **6** | **0.32** | |
| **Emission Factors(EF) are from Conformity handbook tables 6 and 7** | | | | | | | | | |
| **GHGs (metric tons in CO2 eq )= ((CO2*1)+(CH4*21)+(N2O*310))*0.907** | | | | | | | | | |
| **0.907 factor is conversion from US tons to metric tons** | | | | | | | | | |

a-$PM_{2.5}$ = particulate matter less than 2.5 microns
b-$PM_{10}$ = particulate matter less than 10 microns
c-CO = carbon monoxide
f-NMHC= non methane hydrocarbons
g-NOx = nitrogen oxides
h-N2O = nitrous oxides

d-*CO2 = carbon dioxide
e-CH4 = methane
i-GHGs = greenhouse gases

The management approach under Alternative2 is directed at mitigating or reducing the potential for those emissions to affect public exposure, local economies and impair visibility. Effects would potentially be seen in the Boulder project area, as well as the Kings River Canyon west towards lower elevation communities and east towards Cedar Grove. Previous events (i.e. Sheep Fire) suggest that smoke, when dispersal is good, can extend effects towards Mammoth and Bishop in the Great Basin/Owens Valley. As required by the Monument Plan and the mitigations, the local communities and potential visiting public would be made aware of the potential for smoke and particulates in the vicinity during project implementation. Communication tools may include road signs, articles in local papers or community bulletin boards, and personnel on site or at public venues.

There may be opportunities for the scientists involved with air quality to run their models or conduct research as well because the short-term effects of fire and the emissions associated with fire are important for managing air quality. These effects need to be viewed over the long term to better account for the effects of fire on carbon stocks (Hurteau 2011). If the successional pathway that resulted in the pre-fire forest remains unchanged, the recovering forest would transition from a carbon source to a carbon sink, and with sufficient time, the forest would re-sequester all of the carbon lost from both direct and indirect sources.

### *Cumulative Effects*

The cumulative effect area for air quality could potentially reach beyond the planning area for this project and bordering lands within the Giant Sequoia National Monument and surrounding National Parks. Under the No Action Alternative, fuel loading conditions would continue to deteriorate with current and future wildfires expected to exceed capabilities of ground fire suppression. The highest likelihood of wildfire would be in late summer when the smoke emissions would have a higher chance of combining with additional urban generated pollutants which are often transported into higher elevations of the Sierra on hot summer days. A wildfire in the planning area or one extending beyond the planning area would generate higher emissions and join with other sources to increase public exposure for a longer duration. These effects would be seen in the Boulder project area, as well as the Kings River Canyon west towards lower elevation communities and east towards Cedar Grove. Previous events also suggest that smoke, when dispersal is good, can extend effects towards Mammoth and Bishop in the Great Basin/Owens Valley, and therefore result in a higher potential for cumulative effects.

Unlike a wildfire scenario, the prescribed burning under Alternative 2 would take place on days designated as burn days with adequate dispersion by the San Joaquin Valley Air District. Approval is contingent on background air pollution, allocation of burn requests in the air basin, and conditions in adjacent air basins. These regulatory approval factors that reduce the potential for direct and indirect effects would also minimize cumulative effects.

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